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Description

AIR INTAKE SILENCER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present invention claims the benefit of U.S. Ser. No. 60/481,355 filed September 10, 2003.

BACKGROUND OF INVENTION

[0002] The present invention relates generally to air intake silencers for internal combustion engines, and more specifically, to an air intake silencer having a construction which minimizes the transmission of engine noise beyond the air intake silencer.

[0003] While the present invention is applicable to both two-cycle and four-cycle engines, it is particularly applicable to two-cycle engines that produce a power stroke with every rotation of the crankshaft. This combustion process however generates noise that may reverberate back through the intake. That is, as combustion air moves through the air intake of the engine towards a combustion chamber, engine noise is transmitted in a generally opposite direc-

tion, and out of the engine intakes.

[0004] Noise generated by the engine can have a tendency to detract from a user's enjoyment of the apparatus powered by such an engine as well as being generally categorized as a nuisance to anyone nearby during operation. Many efforts have been made to create a quieter operating engine. While on an exhaust side of an engine, a muffler is often implemented to "muffle" that noise transmitted from the exhaust side of the engine, little has been done to lessen the noise emitted from the intake of the engine. Such a simple solution as a muffler is not feasible for an intake side of an engine. The intake side of the engine needs to allow passage of combustion gases therethrough with little restriction. Such a requirement makes the application of a muffler on the air intake infeasible. The air intake needs to remain generally open and unobstructed in order to allow the free-flow passage of adequate amounts of combustion gases therethrough. It is this requirement of a generally open construction that allows for the transmission of engine noise out of the air intake side of the engine.

[0005] Known methods of silencing noise transmitted from the engine through the air intake generally include a tortuous

path under the cover of the engine, lining the air intake path with sound absorbing materials, and/or attaching tuning tubes or resonance chambers in fluid communication with the air intake. Providing an air intake silencer having a tortuous path under the cover of an engine requires the excess consumption of space and having such paths lined with sound absorbing materials can require excess cleaning and detrimentally affects engine performance. That is, these methods obstruct the flow of combustion gases to the intake of the engine and, as a result, can adversely affect engine performance. Additionally, having the air intake paths lined with sound absorbing materials has a tendency to restrict air flow and insulate the engine thereby preventing adequate flow of cooler air into the engine. Such inadequate cooler intake air can result in excessive heat build up within the engine, resulting in poor engine performance.

[0006] Air intake silencers premised on the resonator and/or tuning tube principles provide for improved air flow, when compared to tortuous paths or sound absorbing liners, however, such constructions have their respective deficiencies. Resonator type air silencers use closed volumes having a single inlet where the volume is tuned to cancel

only a predetermined noise frequency. Tuning tube-type air intake silencers generally have a second flow path with a defined length such that a sound wave that travels through the second flow path will "cancel" a predetermined noise frequency that travels through a first path of the air intake. Resonator type air silencers, by requiring a single inlet volume, increase the overall size of the air intake silencer. Similarly, tuning tube type air silencers, by requiring a pair of flow paths, also increase the overall size of the air intake silencer. Additionally, such silencers have a tendency to vibrate as a result of the engine noise being impinged thereon. The vibration of the air intake silencer itself generates additional noise and thus can detract from the overall performance of the air intake silencer.

[0007] It would therefore be desirable to have an air intake silencer that minimizes the transmission of noise from an air intake of an internal combustion engine, while not unduly interfering with the passage of combustion air therethrough.

BRIEF DESCRIPTION OF INVENTION

[0008] The present invention provides an air intake silencer that solves the aforementioned problems.

[0009] An air intake silencer for an internal combustion engine is disclosed having an air flow path formed therethrough. The air intake silencer includes a base and a cover wherein the cover is constructed to be attached to the base and define the air passage therethrough. At least one opening is formed in the base and allows air flow therethrough to efficiently relay combustion gas to an air intake of the engine. The cover is constructed to prevent the transmission of noise from the air intake from transmitting beyond and/or through the air intake housing. Such a construction creates a resonance chamber within the air intake silencer which further improves the ability of the air intake silencer to minimize the transmission of noise from the engine beyond the silencer.

[0010] In accordance with one aspect of the present invention, an air intake silencer assembly having a base and a cover is disclosed. The base includes an opening formed therein and constructed to allow the air passage therethrough. The cover is constructed to be attached to the base so as to enclose an air path therebetween and has a cellular surface formed on an interior surface thereof. Such a construction minimizes the transmission of noise beyond the air intake silencer assembly.

[0011] In accordance with another aspect of the present invention, an air intake silencer having a housing forming an inlet and an outlet in a path therebetween is disclosed. The inlet is constructed to allow air passage therethrough and the outlet is constructed to allow air passage to an engine. A grid extends along at least one surface of the housing thereby preventing the transmission of noise emanating from the air intake of the engine beyond the air intake silencer housing.

[0012] In accordance with a further aspect of the present invention, an outboard motor is disclosed having an engine having at least one cylinder formed therein and wherein each cylinder defines a combustion chamber. The outboard motor includes an air intake constructed to deliver air to the engine and an air box in communication with the air intake and having a flow path therethrough. The air box has an inside surface that is ribbed to prevent the vibration of the air box and thereby minimizes the transmission of noise from the air intake of the engine beyond the air box attached thereto.

[0013] Various other features, objects and advantages of the present invention will be made apparent from the following detailed description and the drawings.

Brief Description of Drawings

[0014] The drawings illustrate one preferred embodiment presently contemplated for carrying out the invention.

[0015] In the drawings:

[0016] Fig. 1 is a perspective view of an exemplary outboard motor incorporating the present invention.

[0017] Fig. 2 is an air intake silencer assembly for use with the outboard motor shown in Fig. 1.

[0018] Fig. 3 is a cross-sectional view along line 3-3 of the air intake silencer assembly of Fig. 1.

[0019] Fig. 4 is a cross-sectional view along line 4-4 of the air intake silencer assembly of Fig. 3.

[0020] Fig. 5 is an alternate embodiment of the air intake silencer assembly shown in Fig. 2.

Detailed Description

[0021] The present invention relates generally to internal combustion engines, and preferably, those incorporating a spark-ignited two-cycle gasoline-type engine. Fig. 1 shows an outboard motor 10 having one such engine 12 controlled by an electronic control unit (ECU) 14 under engine cover 16. Engine 12 is housed generally in a powerhead 18 and is supported on a mid-section 20 config-

ured for mounting on a transom 22 of a boat 24 in a known conventional manner. Engine 12 is coupled to transmit power to a propeller 26 to develop thrust and propel boat 24 in a desired direction. A lower unit 30 includes a gear case 32 having a bullet or torpedo section 34 formed therein and housing a propeller shaft 36 that extends rearwardly therefrom. Propeller 26 is driven by propeller shaft 36 and includes a number of fins 38 extending outwardly from a central hub 40 through which exhaust gas from engine 12 is discharged via mid-section 20. A skeg 42 depends vertically downwardly from torpedo section 34 to protect propeller fins 38 and encourage the efficient flow of outboard motor 10 through water.

[0022] Air is drawn into engine cover 16 and provides combustion gas to engine 12. An air intake silencer, or air box, 50 is attached to engine 12 under engine cover 16 and is designed to silence noise transmitted from an intake passage of engine 12. Air intake silencer 50 is positioned at a front portion 52 of power head 18 over the air intake passage of engine 12.

[0023] Fig. 2 shows air intake silencer 50 of Fig. 1 removed from engine 12 and separated to expose an interior 54 thereof.

Air intake silencer 50 has a base 56 and a cover 58. Base 56 has a number of air intake openings 60 constructed to substantially match a number of air intake throttle bodies of an engine and to allow air passage thereto. Base 56 includes a cover side 62 and an engine side 64 wherein engine side 64 is positioned adjacent engine 12 and is constructed to substantially conform about a profile of engine 12. Such a construction allows air intake silencer 50 to be mounted in close proximity to engine 12 thereby minimizing the volume under engine cover 16.

[0024] Cover side 62 of base 56 has a ridge 66 that extends partially about a perimeter 68 of base 56, wherein perimeter 68 is constructed to substantially match a perimeter 70 of cover 58. A pair of walls 72 extend from cover side 62 of base 56 generally toward cover 58. Walls 72 extend from base 56 generally perpendicular thereto and define a first chamber section 74 and a second chamber section 76 with the walls 72 disposed therebetween. Each wall 72 extends from perimeter 68 of base 56 generally toward first chamber section 74 of base 56 and terminates at an end 78 that is generally curved towards second chamber section 76 of base 56. A plurality of holes 80 extend through base 56 and are constructed to position and/or receive

fasteners (not shown) therethrough for securing base 56 to engine 12 with openings 60 positioned over the air intakes thereof.

[0025] Still referring to Fig. 2, cover 58 includes an edge 82 that extends from perimeter 70 to an exterior portion 84. Exterior portion 84 of cover 58 has an inner surface 86 that faces cover side 62 of base 56 when cover 58 is positioned thereover. A cellular arrangement 88 is formed on inner surface 86 of cover 58 and includes a plurality of interstitial cavities 90 formed between a plurality of intersecting members 92 and 94. Although cellular arrangement 88 is shown as having a "waffle pattern", or "honeycomb", formed thereon, it is understood and within the scope of the claims that the cellular surface 88 could be formed of any pattern that can provide rigidity and/or air silencing. Such patterns could include diagonal intersecting members, an asymmetrical grid, a plurality of generally circular or curved recesses, or the like.

[0026] Similar to base 56, cover 58 also has a pair of walls 96 which protrude from the inner surface 86 of cover 58. Walls 96 originate at an inside surface 98 of edge 82 of cover 58 and extend therefrom and terminate at a pair of ends 100. Walls 96 generally divide inner surface 86 of

cover 58 into a first chamber section 102 and a second chamber section 104 with walls 96 disposed generally therebetween. Cover 58 includes an opening 106 therein constructed to receive a fastener therethrough for securing cover 58 and base 56 to engine 12. Preferably cover 58 and base 56 are glued or welded together along edges 56 and 58.

[0027] When assembled, a majority of perimeter 70 of cover 58 engages a majority of the perimeter 68 of base 56. An opening 108, also shown in Fig. 4, is formed in air intake silencer 50 where perimeter 70 of cover 58 does not engage perimeter 68 of base 56 thereby allowing an air flow path, indicated generally by the arrows 110, into air intake silencer 50 through opening 108. Air flow 110 exits air intake silencer 50 at openings 60 thereby providing combustion gas to an engine attached thereto.

[0028] Fig. 3 shows a cross-section of air intake silencer 50 along reference line 3-3 as shown in Fig. 1. Cover 58 is attached to base 56 thereby forming air intake silencer 50. Perimeter 70 of cover 58 snuggly engages a majority of perimeter 68 of base 56 and walls 96 of cover 58 generally align with walls 72 of base 56. As such, first chamber section 102 of cover 58 is generally aligned with first

chamber section 74 of base 56 thereby forming a first chamber 112 of air intake silencer 50. Similarly, second chamber section 104 of cover 58 is generally aligned with second chamber section 76 of base 56 thereby forming a second chamber 114 of air intake silencer 50. Walls 96 of cover 58 and walls 72 of base 56 cooperate to form a partition 116 between first and second chambers 112, 114.

[0029] Cellular surface 88 extends from inner surface 86 of cover 58 with cavities 90 partially formed by horizontal members 94. As such, noise, indicated generally by arrow 118, exiting an air intake of an engine, enters air intake silencer 50 at opening 60 and is impinged on cellular surface 88 of air intake silencer 50. Cellular surface 88 minimizes internal vibration of air intake silencer 50 as noise 118 impinges thereon. Cellular surface 88, in addition to providing rigidity to cover 58, also disperses, or scatters, noise 118 within air intake silencer 50. Such a construction minimizes the transmission of engine noise 118 through air intake silencer 50 by minimizing the vibration of the silencer and by generating a sound wave tortuous path for noise traveling therethrough, as will be described with reference to Fig. 4. Additionally, having opening 60 constructed to snuggly engage the air intake of engine 12

minimizes the transmission of noise 118 from the air intake of engine 12 around air intake silencer 50. Whereas, some prior art have a silencer chamber under the outboard motor cover to cancel general noise within the volume of space defined by the cover, the present invention is directed to canceling noise 118 directly from the intake of engine 12. Such noise must pass through, rather than around, air intake silencer 50.

[0030] Fig. 4 shows a cross-section of air intake silencer 50 along reference plane 4-4 as shown in Fig. 3. Air flow 110 passes through opening 108 of air intake silencer 50 and enters first chamber 112. From first chamber 112, air flow 110 passes through an opening 120 in partition 116 and into second chamber 114 of air intake silencer 50. Air flow 110 then enters the air intake of engine 12 by passing through openings 60 in base 56 of air intake silencer 50. Noise 118 exiting engine 12 must follow a similar flow path but in reverse. Noise 118 generated in engine 12 exits the engine and enters air intake silencer 50 at openings 60. Noise 118 impinges upon cellular surface 88 and is deflected thereby generally within second chamber 114. As noise 118 is deflected in second chamber 114 between cover 58 and base 56, a portion thereof, indicated by ar-

row 122, exits second chamber 114 at opening 120 in partition 116 and enters first chamber 112. Noise 122 within first chamber 112 is subject to much the same deflection between cellular surface 88 of cover 58 and base 56. As such, rather than passing directly through air intake silencer 50, noise 118 must follow a relative tortuous path through second chamber 114 and first chamber 112 before exiting air intake silencer 50. Additionally, noise 118 is subjected to the scattering effect of cellular surface 88 within both chambers 112 and 114.

[0031] Ultimately, a portion, indicated generally by arrow 124, of noise 122 that enters first chamber 112 will escape air intake silencer 50 at opening 108. However, due in part to the dual chamber construction of air intake silencer 50, the magnitude of noise at 124 is less than the magnitude of noise at 122, which in turn is less than the magnitude of noise at 118. Cellular surface 88 also minimizes the transmission of noise through the air intake silencer by adding rigidity and repeatedly deflecting the noise that is impinged thereon. Additionally, cellular surface 88 of air intake silencer 50 prevents the vibration of the air intake silencer which in turn minimizes the transmission of noise through cover 58 of the air intake silencer. As such, air

intake silencer 50 minimizes the transmission of noise from the air intake of an internal combustion engine beyond the air intake silencer while not impeding the flow of combustion gases therethrough.

[0032] An alternate embodiment of air intake silencer 50, air intake silencer 200, is show in Fig. Similar to air intake silencer 50, air intake silencer 200 includes a base 202 and a cover 204. A perimeter 205 of cover 204 is constructed to snugly engage a perimeter 206 of base 202. Air intake silencer 200 includes an air intake opening 208 and is constructed to be attached over one air intake of a throttle body of an engine. A wall 210 extends generally perpendicular from a surface 212 of base 202. An end 214 of wall 210 maintains a separation 216 between wall 210 and perimeter 206 of base 202. Another end 218 of wall 210 is coterminous with perimeter 206 of base 202.

[0033] Cover 204, similar to cover 58 of air intake silencer 50, includes a plurality of interstitial cavities 220 formed between a plurality of intersecting members 222, 224. A wall 226 extends from an inner surface 228 of cover 204 and has a first end 230 and a second end 232. First end 230 is coterminous and begins at a perimeter 205 of cover 204. Second end 232 does not extend all the way to perimeter

205 and maintains a separation 236 therebetween.

[0034] When cover 204 is positioned about base 202, wall 226 of cover 204 generally aligns with wall 210 of base 202. Such a construction forms an air flow chamber 238 and a single inlet resonance chamber 240 between cover 204 and base 202. End 232 of wall 226 of cover 204 substantially aligns with end 214 of wall 210 of base 202 thereby maintaining separations 216, 236 between base 202 and cover 204. The combination of separation 216 and separation 236 forms an air passage 242 between air flow chamber 238 and single inlet resonance chamber 240. Single inlet resonance chamber 240, having one air inlet passage 242, operates as a resonance chamber and effectively cancels a portion of the sound emanating from the air intake opening of an engine attached thereto. Additionally, the interstitial cavity 220 construction of cover 204 provides rigidity and stability to the air intake silencer 200. The closed volume resonance chamber, in addition to the interstitial cavity construction of the cover, further minimizes the transmission of noise from an air intake of an internal combustion engine while not impeding the flow of combustion gases therethrough.

[0035] Regardless of which embodiment is practiced, the con-

struction of the air intake silencers disclosed herein provides for relatively efficient and quite operation of the engine which in turn increases a user's enjoyment of a vehicle powered by an engine so equipped.

[0036] Although disclosed as having a multiple component construction, it is equally appreciated and claimed herein that the air intake silencer of the present invention could be of a unitary construction. The air intake silencer has been shown as a two part assembly merely to facilitate explanation of the structure contained therein.

[0037] While the present invention is shown as being incorporated into an outboard motor, the present invention is equally applicable with many other applications, some of which include inboard motors, snowmobiles, personal watercrafts, all-terrain vehicles (ATVs), motorcycles, mopeds, lawn and garden equipment, generators, etc.

[0038] The present invention contemplates the use of an internal combustion engine with one or more pistons, and more specifically, an air intake silencer attached thereto. The air intake silencer includes a base and a cover wherein the cover has a cellular surface and is constructed to be attached to the base thereby enclosing an air path therebetween. The base includes at least one opening constructed

to allow air passage therethrough and into an engine attached thereto. Such a construction prevents noise transmitted from the air intake of the engine from passing beyond the air intake silencer.

[0039] In accordance with one embodiment of the present invention, an air intake silencer assembly includes a base and a cover. The base includes an opening formed therein and constructed to allow air passage therethrough. The cover is constructed to be attached to the base so as to enclose an air flow path therebetween and has a cellular surface formed on an interior surface thereof. Such a construction minimizes the transmission of noise from the air intake of an engine through the air intake silencer assembly.

[0040] In accordance with another embodiment of the present invention, an air intake silencer includes a housing forming an inlet and an outlet of a path therebetween. The inlet is constructed to allow air passage therethrough and the outlet is constructed to allow air passage to an engine. A grid extends along at least one surface of the housing thereby minimizing the transmission of noise emanating from the air intake of the engine through the air intake silencer housing.

[0041] In accordance with a further embodiment of the present

invention, an outboard motor includes an engine having at least one cylinder formed therein and wherein each cylinder defines a combustion chamber. The outboard motor includes an air intake constructed to deliver air to the engine and an air box in communication with the air intake and having a flow path therethrough. An inside surface of the air box is ribbed to prevent the vibration of the air box and thereby silence the air intake of the engine.

[0042] The present invention has been described in terms of the preferred embodiment, and it is recognized that equivalents, alternatives, and modifications, aside from those expressly stated, are possible and within the scope of the appending claims.